were unattractive, loud and harsh, more like the calls of Ussher's Spinetail *T. ussheri* than like those of Cassin's or Sabine's Spinetails.

Our only information on breeding comes from the trapped bird, which contained fairly large ova. Although birds frequently descended into partial clearings with dead and broken trees, none was ever seen showing interest in potential nest-holes. A bird in primary moult was seen in October.

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Data on *Lagonosticta rhodopareia bruneli*

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Erard & Roche (1977) described under the name *Lagnosticta rhodopareia bruneli* a couple of firefinches collected in the mountains of Lam, near Dagbao (7° 39'N, 15° 53'E), 25 km southeast of Baibokoum, in southern Tchad, on the border with the Central African Republic. Further brief visits to this locality were made by one of us (J.B.) between January and May 1978. Supplementary information on the habitat was obtained, 2 further males were collected, and some vocalisations recorded. It is this new material which is now presented and analysed.

Morphological characters

The 2 new specimens, collected 7 May 1978 (C.G. 1979–634, 635 in the Paris Museum), are males in relatively fresh dress. It should be recalled that the 2 earlier ones, dated 16 April, were near the end of a complete moult. It seems that the male (type) described by Erard & Roche was an immature moulting into adult dress. The ochraceous tone on the abdomen would have disappeared with the completion of the moult, and been replaced by a more crimson coloration, the red of the face extending further onto the chest, which is a slightly vinous pink. These details in no way invalidate the racial characters previously defined, and which may be briefly repeated. The male has the crown and nape uniform neutral grey, clearly demarcated from the maroon of the back and wing-coverts; the face (superciliaries, lores, cheeks, chin, throat) and upper chest very bright red; the rest of the underparts pink to a slightly vinous crimson-red. The female has the face (the cheeks are only slightly washed with pink) and the underparts paler than in the male, the abdomen a little more ochraceous. Sexual dimorphism is thus relatively slight.

Measurements (in mm) are:

	Wing	Bill	Tail
♂♂	50·5–51 (50·6)	11·5–12 (11·8)	44–44·5 (44·1)
♀	49	11	44·5

The bill is longest, most slender and least globular in *bruneli*. We will not repeat here its distinction from the other races, namely *jamesoni* (including *taruensis*), *ansorgei*, *rhodopareia* and *virata*. It will suffice to state that from their morphological analysis Erard & Roche associated *bruneli* with *virata* rather than the other forms. They also laid emphasis on the observations on captive birds by Goodwin (1964, 1969) and Harrison (1957, 1963), which strongly suggest that *virata* may be specifically distinct from *jamesoni*.

Habitat

Erard & Roche have stressed the apparent similarity (at least in physiognomy) in the habitat of *bruneli* and *virata*, contrasting somewhat with that of the other forms. Below we will merely define more precisely that of *bruneli*.

The mountains of Lam are extensions of the crystalline massifs of Yade, culminating in the Central African Republic at 1420 m, and in Adamawa in Cameroun at c. 1700 m, their geological origin giving them a broken outline. They resemble rocky pedestals, essentially granitic, with some gneissic formations, in which numerous narrow valleys alternate with successions of level areas of bare rock and detritus, of which the area around Dagbao is typical. Torrential streams flow in the rains, but dry up almost completely in the dry season, leaving only small pools or holes of water here and there.

This region is within the Soudano-Guinean zone with 5 dry months (November to March) and a rainy season (May to October, average 1300 mm) after a prehumid period in April. Temperatures scarcely exceed 38°C in the dry season, but the difference between day and night can be as much as 20°, certain absolute minima being c. 10°. The relative humidity varies, 20–70% in the dry season and 70–100% in the rains. In general the vegetation is a shrubby savanna typical of the Soudano-Guinean zone, disturbed by annual fires.

At Dagbao the level areas are clothed in a shrubby, degraded vegetation in which *Detarium*, *Parinari*, *Grewia*, *Hymenocardia*, *Terminalia* and *Anona* dominate. By contrast, the slopes of the rocky mountains, unaffected by fires, are sheltered by certain large trees; some peculiar to these parts such as *Pterocarpus luceus* (inhabiting arid mountains), *Ficus glumosa* (characteristic of rocky regions within the Soudano-Guinean zone), *Lannea schimperi* (particularly abundant on the high plateaux of Adamawa) and *Stereospermum* (originally from Fouta Djalon, Guinea). Others more widespread are *Prosopis*, *Anogeissus*, *Cassia* and *Burkea*. It is uniquely in these rocky areas that *bruneli* dwells. The other *Lagonosticta* present, *rara*, frequents the level, shrubby areas.

The site under consideration is a plateau of large granitic slabs, bordered on the south-southeast by a series of steep, denuded hillocks, from the bases of which extends broken, rocky rubble. From this rubble there protrudes scattered shrubby vegetation with, here and there, clumps of large trees, clinging in the fractures where there is still a little fertile ground. The biotope of *bruneli* is provided by the zone intermediate between the surface of the densely shrubby savanna characterised by *Hymenocardia*, *Bauhinia*, *Anona*, *Detarium*, etc., and the steep, denuded slopes inhabited by bird species such as *Onychognathus morio*, and also *Caprimulgus tristigma*, *Cercomela familiaris*

and *Cisticola emini*. The ground surface alternates with rocky rubble, bushy vegetation, denuded laterite slabs, small areas of gramineous plants, the whole with scattered clumps of large trees (*Prosopis*, *Anogeissus*, *Pterocarpus*, *Ficus*, *Lannea*).

Although not abundant, *bruneli* is not rare in this habitat; a count revealed 3 pairs over a distance of 1 km. The social unit is clearly the pair. The birds fly from rock to rock, on which they like to perch and call as recorded below. Quite wary, on the least alarm they take refuge in leafy bushes or in fractures in the rocks, perching only rarely in trees. They feed mainly on small seeds of gramineous plants, and readily resort to the large granitic slabs where the village women come to pound their millet or dry their cassava.

Acoustic comparison between rhodopareia *and* bruneli

The sound elements used are from the recordings made by J. Brunel near Dagbao on 15 May 1978 with a magnetophone UHER 4000 and a parabolic reflector; the disc of Nicolai in the series Kosmos: 'Prachtfinken'; and the data provided by Payne (1973), mainly concerning *jamesoni*. The sounds available have provided tracings in an amplitude-frequency on a Kay Elemetrics 7029A SonaGraph on a scale of 160 to 16000 Hz with a time resolution of 1·6 second per tracing. We thank Professor F. Bourlière for having placed the necessary equipment at our disposal.

Before studying the analogies or divergences which may be apparent between *L. rhodopareia* and *bruneli*, one must first compare the two different samples of *L. rhodopareia jamesoni* presented by Nicolai and by Payne. Nicolai presents 8 structures of different notes belonging to 5 types (Fig. 1): (A). Ascending note, strongly modulated (3000–6500 Hz), in rapid series (alarm). (B1). Sharp descending note (7500–5500 Hz). (B2). Note first ascending, then going through evolutions as in B1. (C1). Ascending a little, short, final accentuation above 3500 Hz. (C2). Related to preceding, more rapidly modulated. (C3). Likewise related, persisting only in an accentuation above 3500 Hz. (D). Gently ascending, 2500 to 7500 Hz. (E). Halting note, of complex harmonic structure, average frequency progressively ascending.

In his audiospectrograph 6, Payne (1973: 69) shows 8 types of different notes (counting as a type the 3 alarm notes a, b and c, all very similar, and as another type e and f, similar in the slowness of the variations of frequency and in the extent of modulation).

Between these 2 authors there are only 3 notes analogous or identical: (A) of Nicolai=a, b and c of Payne; (C2) of Nicolai=d of Payne; (D) of Nicolai=e and f of Payne. Apart from these 3 common to both, there are 2 original notes for Nicolai and 5 for Payne. This shows that the samples are very incomplete, but this is not unexpected, since neither author attempted to study numerous individuals of all ages from all regions and in all situations, captive or free, of this one species.

As to *bruneli*, the available elements of its repertory can be classed as follows (Fig. 2):—(A). Ascending note strongly modulated (3000–6500 Hz) in rapid series (alarm). The note is identical in *jamesoni*, in which however the rhythm is more rapid (Fig. 1.A). (B). Descending note, sharp, with slight final accentuation (7000–4000 Hz), analogous to that of *jamesoni* (Fig. 1B), isolated or in series (song). (C1). Short vibrant note, sharp (7000 Hz), near to *jamesoni* (Fig. 1. C1). (C2). Short note, sharp, slack (6000 Hz). (C3). Very short note, sharp, repeated (6000 Hz), analogous to that of *jamesoni* (Fig. 1. C3). (D). Note descending slowly in frequency, finally ascending, emitted

in series in the form of a song. Although this note has no equivalent in *jamesoni*, one finds it in an imitation of *jamesoni* made by *Vidua chalybeata amauropteryx* (audiospectrograph 11 of Payne, 1973: 74, last note in series f). (E). Note of complex structure of average frequency, somewhat ascending (compare *jamesoni*, Fig. 1.E).

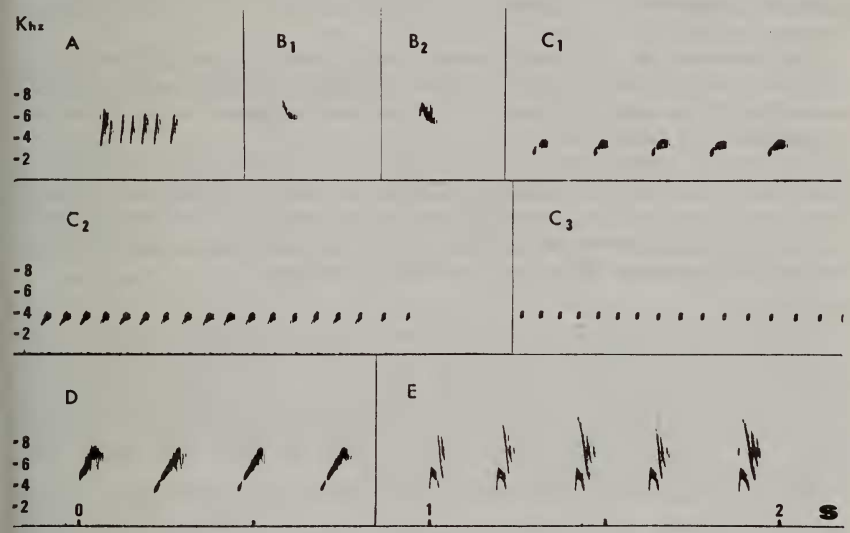

Fig. 1. *Lagonosticta rhodopareia jamesoni*. Sonagram after the disc of Nicolai (wide-band filter, 300 Hz, scale of frequency 160–16000).

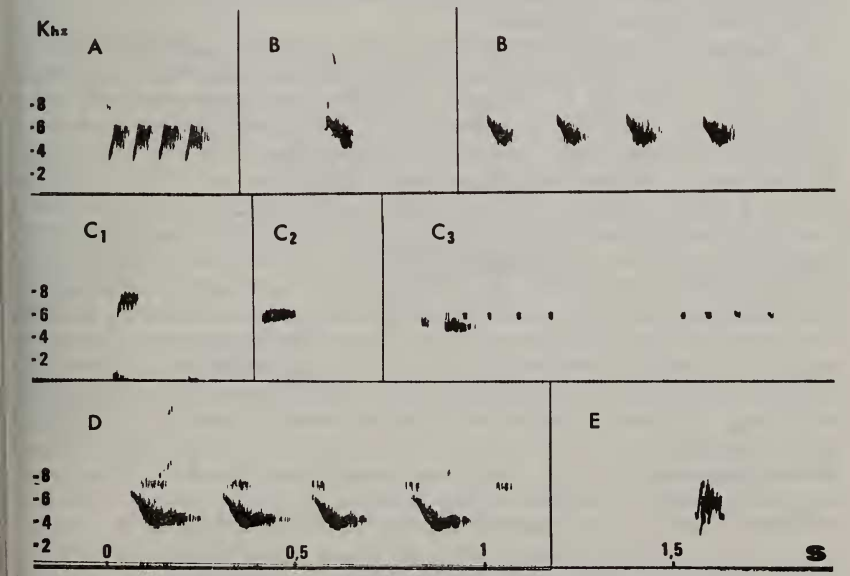

Fig. 2. *Lagonosticta rhodopareia bruneli*. Sonagram of recordings by J. Brunel (wide-band filter, scale of frequency 160–16000).

Thus we have for *bruneli* 7 types of notes. A and B are practically identical with A and B in *jamesoni*; C1 and C3 resemble strongly *jamesoni* C1 and C3; C2 in *bruneli* approaches h of Payne. Only notes D and E have no direct equivalent in *jamesoni*. On a final assessment, *bruneli* and *jamesoni* have 5 types of notes in common, even 6 if the imitation of *Vidua* is accepted. This significant proportion of 6 out of 7 notes clearly shows the affinity between these 2 populations.

Furthermore, the structure of song is simple and identical: either a series in slow rhythm of notes (some 5 per second) strongly and slowly modulated in frequency, or a series in rapid rhythm of notes (some 10 to 12 per second) in general little modulated.

The acoustic divergencies between *bruneli* and *jamesoni* (not exceeding, or even less important than, those noted in the 2 series of *jamesoni* studied above) are limited, and concern essentially only the rhythm of the *roulade* ('roll') of alarm and the frequency of the notes, with little or no modulation—c. 6000 Hz for *bruneli* as against 3500 Hz for *jamesoni*.

Discussion

Studies of the behaviour of *Lagonosticta* relate essentially to birds in captivity (Goodwin 1964, 1969, Harrison 1957, 1962 a, b, 1963, Kunkel 1967, Nicolai 1964) and were concerned essentially with clarifying Estrildidae systematics. Only Morel (1973) znd Payne (1973) were really concerned with field studies. Morel worked only on *L. senegala*, and Payne was mainly interested in vocalisations imitated by *Hypochera*.

Colour-patterns, especially those exhibited laterally for display, together with vocalisations are important in sexual and even individual recognition. By contrast, little is known about visual and acoustic mechanisms together in specific recognition. In the absence of experimental work, one cannot actually determine the significance of any particular morphological or acoustic difference in specific isolation.

In *Lagonosticta*, visual stimuli in the form of highly ritualised displays, would seem more important than voice in pair-formation (cf. for example Morel, 1973: 100, for *L. senegala*). However, one cannot exclude voice entirely in pair-formation, as attested for *L. rhodopareia jamesoni* by Immelmann & Immelmann (1967: 625) from their observations *in natura* in Rhodesia. They found that one male keeps apart from a group and displays with the stem of a plant, singing at the same time and this attracts any unattached female. On her approach there follows a specific greeting behaviour ('Greeting display' of Goodwin, 'Recognition posture' of Harrison, 'Curtseying' of Kunkel). In fact, Immelmann & Immelmann do not indicate whether the stem display and the song are delivered simultaneously or alternately and this is important, since the observations on *Lagonosticta* in captivity, or even on *senegala* in the wild, stress that during the stem display the vocalisations emitted do not constitute a true song but are isolated notes audible at only very short range. By contrast, males are known to emit a solitary song (inhibited by the presence of a congener, cf. Harrison 1962 b), which is varied and relatively far carrying. In *L. rhodopareia*, according to Goodwin (1964: 105), this solitary song is a mixture of the elements of its repertoire, exclusive of the alarm notes. So one may ask whether the observations of the Immelmanns do not in fact concern unattached males trying to attract females by their solitary song, performing the stem display on their approach, followed by ritual greetings when still closer together. In these circumstances, the

solitary song provides for specific identification of the male by the female. Recognition would be followed (by the female) or started (by the male) according to visual criteria (behaviour and/or colour patterns) during displays at close quarters.

Accepting that all *Lagonosticta* showing much red in the plumage evoke aggression in other males of the genus, one might suppose that the meeting of a female *bruneli* with a male *rhodopareia* (nominate, *jamesoni* or *ansorgei*) would compel such reactions in the latter. But it must be stressed that the female of *bruneli* is not completely andromorphic (absence of red on the cheeks, presence of ochraceous on the underparts), so that a male's aggression might not be roused, and the female be recognised as such by her behaviour on approach. Likewise, there is nothing to stop one supposing that a male *bruneli* would accept a female *rhodopareia* despite her dull colour. Goodwin (1969) stresses the physiological incompatibility which seems to exist between *jamesoni* and *virata*, and to suggest that they are specifically distinct. A male *jamesoni* and female *virata*, after a long period of reciprocally aggressive behaviour (perhaps due to their similarity in colour, though nevertheless with a divergence in voice), did finally pair off and numerous eggs were laid, of which only one hatched. We cannot assume the existence of ethological isolating mechanisms between *virata* and *bruneli*, all the more so because the displays of *bruneli* remain unknown; while the vocalisations of *virata*, described by Harrison and by Goodwin (who found differences from those of *jamesoni*), have not been the subject of mechanical recordings but only of onomatopoeic transcriptions and descriptions not permitting precise acoustic comparisons.

Table 1

		Rhodopareia jamesoni		*R. bruneli*	
	Structure	Rhythm	Frequencies	Rhythm	Frequencies
'Roulade' ('Roll') or 'Rattle' (Fig. 1 and 2. A)	Slope of modulation less strong in *bruneli*	29/sec.	3000–6500 Hz	14·5/sec.	3000–6500 Hz
'Trill' (Fig. 1 and 2. C_3)	notes little or unmodulated in both	17/sec.	3500 Hz	12·5/sec.	6000 Hz
Song		Average 4·8 notes /sec.	3500–7500 Hz	Average 4·5 notes /sec.	4000–7000 Hz
Note isolated not modulated in frequency (Payne 6=h, i and Fig. 2. C_2)			long note 4500 Hz short note 3500 Hz		? short note 6000 Hz
Note isolated moderately modulated, descending in frequency	structures very close		5500–7500 Hz		4000–7000 Hz
Note isolated, complex (Fig. 2. E)			?		Average frequency around 5000 Hz

Table 1. Resemblances and divergences in the vocalisations of *Lagonosticta rhodopareia jamesoni* and *L. r. bruneli*.

Among those differences which we have revealed in comparing the vocalisations of *bruneli* and *rhodopareia* (see Table 1), those in the rhythm of the

'roll' or 'rattle' (corresponding to the alarm call) are doubtless important in specific recognition, although this call may be made during relief at the nest (Goodwin 1969). The trill and the short unmodulated note are in the category of contact calls, and can be utilised in the song (cf. Payne 1973: 88). There is no answer to the question whether, in fact, the difference of rhythm of the trill and above all the use of well separated frequencies, constitute parameters of specific acoustic recognition.

Thus we continue to consider *bruneli* as a well marked geographical race of *L. rhodopareia*. The important differences in colour and voice show that it is an old isolate, perhaps suitably regarded as a semispecies.

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Further notes on uncommon forest birds in Ghana

by M. A. Macdonald

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Macdonald & Taylor (1977) described the occurrence of several rare or little known birds in forest habitats in Ghana. The notes below, which are based mainly on work done between September 1977 and July 1978, supplement the earlier observations. Co-ordinates for the places mentioned are shown in Table 1.

CASSINAETUS AFRICANUS Cassin's Hawk-eagle. On 17 Nov 1977 an adult was apparently incubating on the nest found in the previous December in the Pra Suhien Forest Reserve (Macdonald & Taylor 1977). An active colony of White-naped Weavers *Ploceus albinucha* surrounded the nest. The other adult eagle perched in the open in nearby trees, often close to the observer, showing little sign of alarm. Occasionally it called a rather weak cracked